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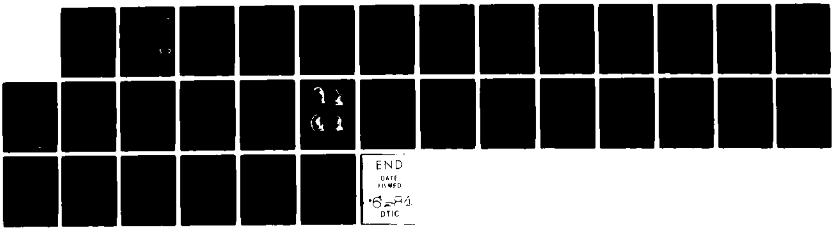

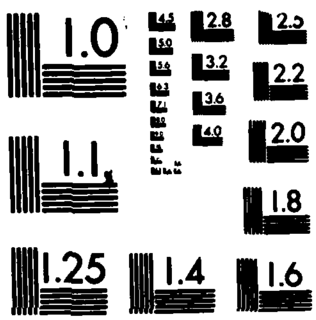

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DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

Bethesda, Maryland 20084

AD-A140 816

CORRELATION OF PRESSURE DISTRIBUTION ON THE BLADE OF ITTC PROPELLER COMMITTEE MODEL PROPELLER MP 282

by

Ki-Han Kim

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February 1984

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CORRELATION OF PRESSURE DISTRIBUTION ON THE BLADE OF ITTC PROPELLER COMMITTEE MODEL PROPELLER MP 282

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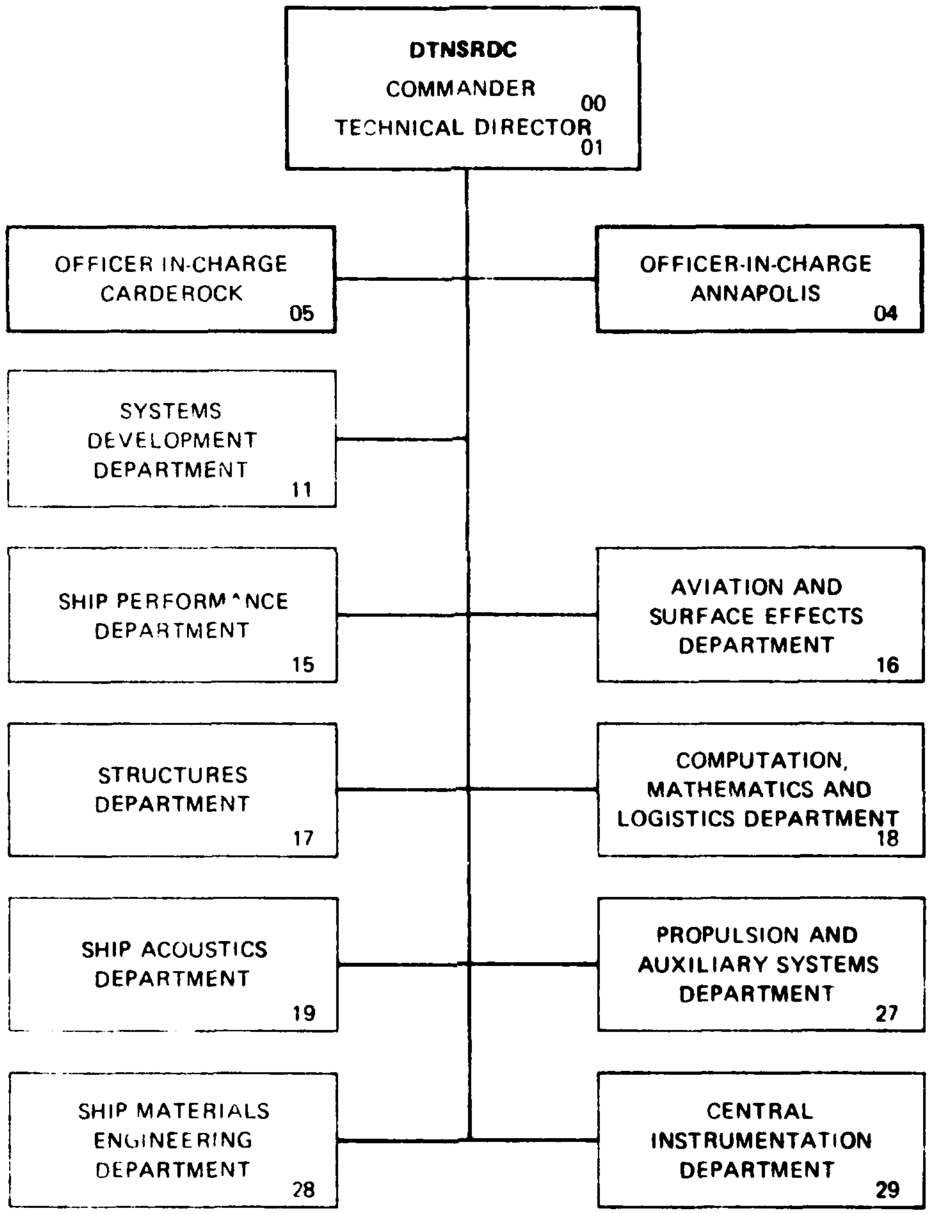

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The open-water performance and the pressure distribution on the blades of ITTC Model Propeller MP 282 (diameter of 950 mm) operating in uniform flow were computed using the Computer Code PUF-2, originally developed at Massachusetts Institute of Technology. ~~(MIT)~~ The computed results are compared with experimental measurements made at Ishikawajima-Harima Heavy Industries ~~(IHI)~~ Ship Model Basin in Japan. The predicted thrust and torque

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ABSTRACT

The open-water performance and the pressure distribution on the blades of ITTC Model Propeller MP 282 (diameter of 950 mm) operating in uniform flow were computed using the Computer Code PUF-2, originally developed at Massachusetts Institute of Technology (MIT). The computed results are compared with experimental measurements made at Ishikawajima-Harima Heavy Industries (IHI) Ship Model Basin in Japan. The predicted thrust and torque coefficients were about 10 percent less than the experimental values over the range of advance coefficients. In general, the predicted pressure distributions are in satisfactory agreement with the experimental measurements.

ADMINISTRATIVE INFORMATION

This work was funded by the Propulsor Technology Subprogram of the 6.2 Ships, Subs and Boats Program and performed at the David W. Taylor Naval Ship Research and Development Center (DTNSRDC) under Work Unit 1540-002.

INTRODUCTION

In this report the open-water performance and the pressure distribution on the blades of ITTC Model Propeller MP No. 282 operating in uniform flow were computed using the computer code PUF-2, originally developed at MIT.[1*] The computational algorithm for the pressure distribution was developed and implemented to the existing code, PUF-2, by Kobayashi.[2] The computed results were compared with the experimental measurements made at IHI Ship Model Basin.[3]

COORDINATE SYSTEM AND BLADE GEOMETRY

The blade outline and the principal characteristics of Model Propeller MP 282 are shown in Figure 1 and Table 1, respectively. The coordinate system used in PUF-2 is shown in Figure 2. In Figure 3, the definition of the blade surface ordinates provided by the ITTC Propeller Committee (ITTC PC) and that of the PUF-2 are compared. According to the ITTC PC definition, the chordlength was defined along the "profile base line" and the pitch angle was defined by the angle between the profile base line and the line in the plane of the propeller rotation. In PUF-2 coordinate system, the chordlength was defined along the nose-tail line and the pitch angle was defined by the angle between the nose-tail line and the line in the plane of propeller rotation.

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*A complete listing of references is given on page 7.

Therefore, the following coordinate transformation was made to convert ITTC PC data in oxy coordinate system into the o'x'y' system used in PUF-2 (see Figure 3):

$$x' = x \cos\alpha - y \sin\alpha + y_o \sin\alpha \tag{1}$$

$$y' = x \sin\alpha + y \cos\alpha - y_o \cos\alpha \tag{2}$$

where y_o is the ordinate at the leading edge in oxy system, and α is the induced pitch angle due to the above coordinate transformation defined by

$$\alpha = \tan^{-1} \frac{y_o}{c} \tag{3}$$

This coordinate transformation results in the new chordlength, pitch angle, skew, and rake in accordance with the PUF-2 definition (see Figures 1 and 2):

$$c' = c/\cos\alpha \tag{4}$$

$$\phi'_P = \phi_P + \alpha \tag{5}$$

$$\theta_s = \frac{1}{r} \; PQ \cos\phi_P - P'Q \cos(\phi_P + \alpha) \tag{6}$$

$$i_T = PQ \sin\phi_P - P'Q \sin(\phi_P + \alpha) \tag{7}$$

A small computer program was developed to convert the original data into the data for PUF-2 input. Table 2 shows the radial distribution of the pitch, rake, skew, and the chordlength of the new geometry after the coordinate transformation. In Table 3, the original table of offsets (in mm) as provided by ITTC PC were shown. Table 4 shows the new table of offsets about the nose-tail line after the coordinate transformation. In Table 5, the same data as in Table 4 are shown together with camber and thickness distribution at different fractions of chord from Table 4. The 17 new fractions of chord, x_c (0.0, 0.01, 0.025, 0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 0.95, 0.975, 0.99, 1.0) were required by PUF-2 input.

RESULTS AND DISCUSSION

Since the original PUF-2 code was written for a propeller geometry with fixed thickness and camber distribution throughout the radius (only the maximum thickness and camber change radially), the algorithm had to be modified slightly in order to handle the blade geometry with radially varying camber and thickness distribution such as the present propeller (see Table 5). The open-water performance was calculated in terms of K_T, K_Q, and efficiency at 6 different advance coefficients: J = 0.9, 0.95, 1.0, 1.054, 1.1, and 1.163. In the computations a value of 0.007 was used for the drag coefficient for all J values. The computed values of K_T and K_Q were compared with experimental results in Table 6. The predicted K_T and K_Q were about 15 percent and 10 percent, respectively, lower than the experimental values over the range of advance coefficients. The efficiency was about 7 percent lower than the experimental results. The discrepancies in open-water performance are somewhat larger than some previous correlation results.[1]

Some slight modifications were made to the algorithm of Kobayashi[2] in order to improve the pressure prediction. With this corrected version of the program, the pressure distribution on the same blade (Propeller 4498) as in Reference 2 was calculated and compared with other theory. The correlation was improved.

The pressure distribution on the blade of Propeller MP 282 was calculated for a range of J values. The computed results were shown in Tables 7 through 12 for each J value. The pressure coefficients were calculated on both the suction and the pressure sides at selected radii (r/R = 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9). The pressure coefficients were nondimensionalized by the local inflow at each radius:

$$C_p = \frac{P - P_\infty}{\frac{1}{2}\rho V_R^2} \tag{8}$$

where $V_R = \sqrt{V_A^2 + (2\pi nr)^2}$.

In these tables, the lift coefficients, C_L, are also shown at each radius. The lift coefficient was computed by integrating the difference in pressure coefficients:

$$C_L = \frac{1}{c} \int_0^c \Delta C_p \, dx_c \tag{9}$$

For each radius, C_p was computed at discrete fractions of chord, from 2.5 percent to 92.5 percent of the chord. Therefore, at the leading and the trailing edges, ΔC_p was arbitrarily set to zero and the discrete values of ΔC_p were curve-fitted using cubic-spline functions before integration.

Table 13 shows the experimental measurements of the pressure distribution made at IHI Ship Model Basin.[3] In Figures 4 and 5, the experimental measurements and the predicted C_p were compared at J = 1.054 and J = 1.163, respectively. The experimental measurements were made at Reynolds number, $R_n = 1.9 \times 10^6$. The calculated pressure coefficients are in agreement with measurements on the pressure side except near the leading edge, but generally overpredict the suction side pressure. The agreement at reduced J value is better than that at increased J value. In general, the predicted values are in agreement with the experimental measurements throughout the radius at two different J values.

In Figure 6, the oil-film test results reconstructed from the photographs in Reference 3 are shown at two different Reynolds numbers; 1.1×10^6 and 2.6×10^6, respectively. It is observed that the suction side flow at $R_n = 1.1 \times 10^6$ is somewhat different from the flow at $R_n = 2.6 \times 10^6$. At the reduced R_n condition, the flow patterns on the suction side have significantly reduced shear stress over the forward part of the blade and a clear separation occurs slightly past midchord. On the pressure side, reduced shear regions occur toward the leading edge and some indication of a leading-edge laminar separation bubble occurs at both Reynolds numbers.

No surface flow patterns are presented in Reference 3 for the test R_n of 1.9×10^6. However, it is possible that separation occurred near 0.7 fraction of chord on the suction side and at the leading edge on the pressure side in the form of a bubble. Such separation would explain the suction peak on the pressure side near the leading edge and the pressure peak measured at 0.7 radius at 0.7 fraction of chord (measurements were not made at a similar chordwise position at other radii) (see Figures 4 and 5). It is further hypothesized that the suction side separation is a thin layer with only minor influence on the pressures away from the separation line.

CONCLUSIONS AND RECOMMENDATIONS

The steady pressure distribution on a large diameter model propeller predicted by a modification to the Computer Code PUF-2 is in satisfactory agreement with experimental measurements. Viscous effects such as suction-side separation and leading-edge laminar bubble separation on the pressure side may have occurred during the experimental pressure measurements. However, it appears that the viscous phenomena have only a local effect on the pressure distribution.

In order to assess the validity of the modified computer code for blade pressure distribution, it is recommended that more comparisons be performed for a wide range of propellers and operating conditions. Recently, Greeley and Kerwin[4] developed a more advanced numerical lifting surface theory and a computer code PSF for the prediction of propeller steady performance. It is recommended that this code be modified to provide for prediction of pressure distribution. Since steady performance predictions by PSF were shown to be in better agreement with measurements than those by PUF-2, it is anticipated that the pressure prediction by PSF will be better than that by PUF-2.

ACKNOWLEDGMENT

The author is very grateful to Dr. Terry Brockett for many helpful discussions throughout the course of this project.

REFERENCES

1. Kerwin, J.E. and C-S Lee, "Prediction of Steady and Unsteady Marine Propeller Performance by Numerical Lifting-Surface Theory," Transactions, The Society of Naval Architects and Marine Engineers, Vol. 86 (1978).

2. Kobayashi, S., "Prediction of Pressure Distribution on Propeller Blade Surface Using Numerical Lifting Surface Theory," ORI, Inc. Technical Report No. 2117 (1982).

3. "Experiments for MP 282 Large Scale Model Propeller," IHI Ship Model Basin, Report No. 450-0 (1978).

4. Greeley, D.S. and J.E. Kerwin, "Numerical Methods for Propeller Design and Analysis in Steady Flow," Transactions, The Society of Naval Architects and Marine Engineers, Vol. 90 (1982).

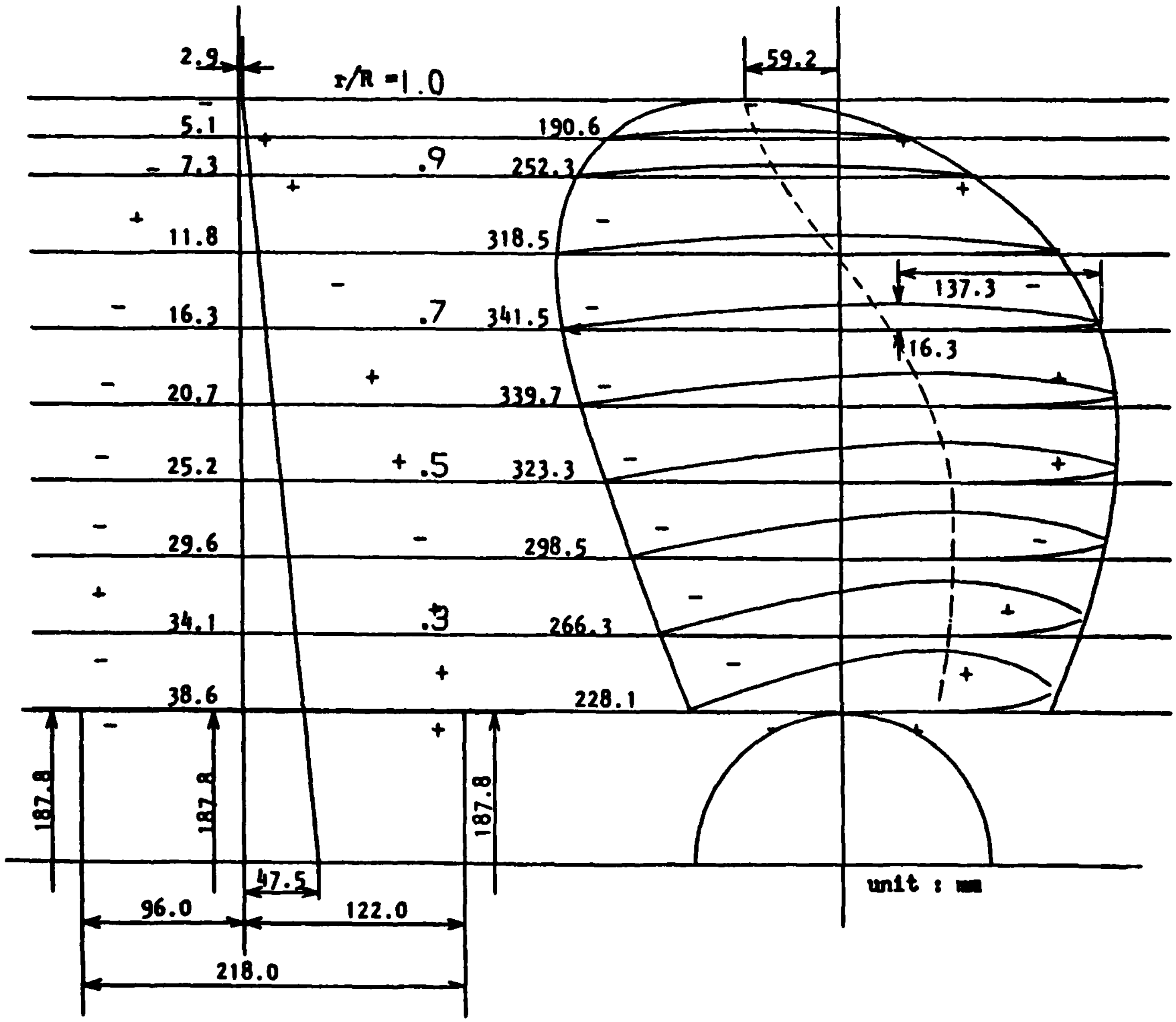
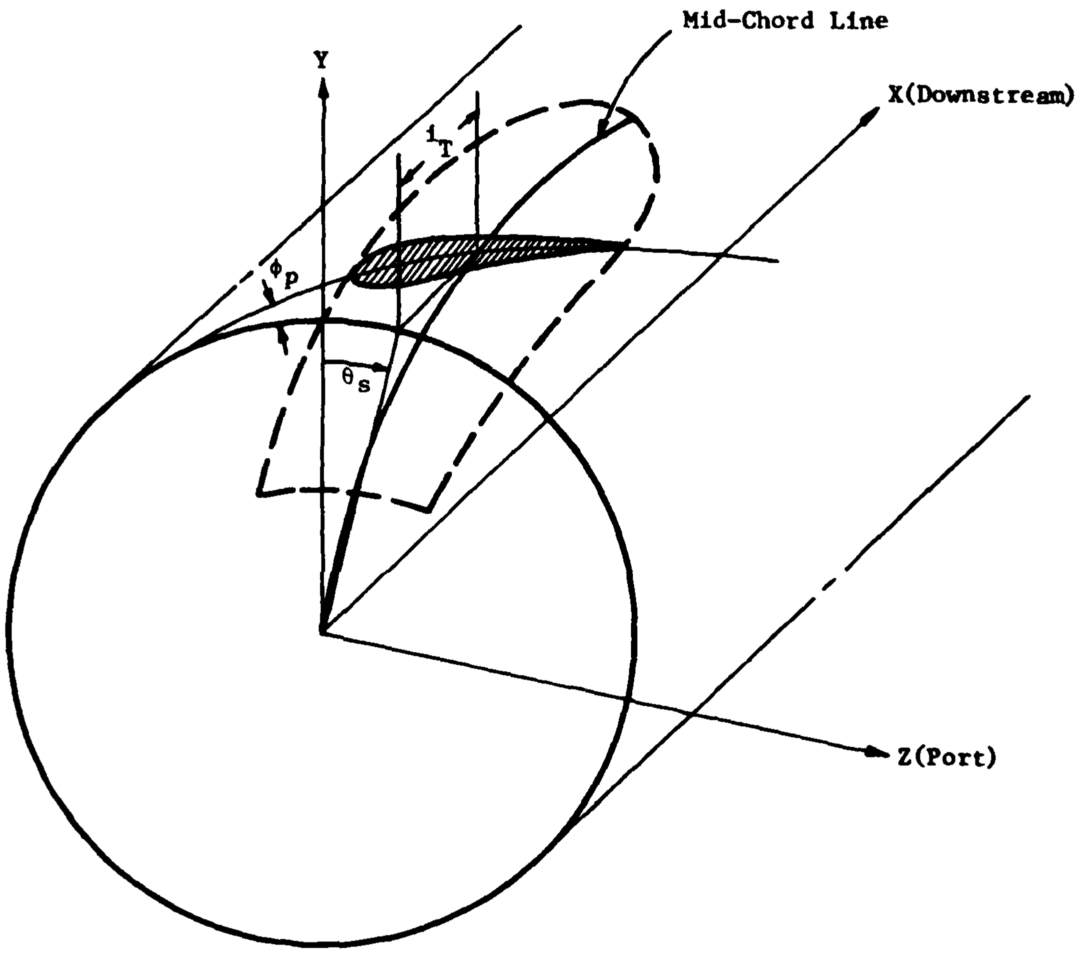


Figure 1 - Blade Outline of Model Propeller MP 282

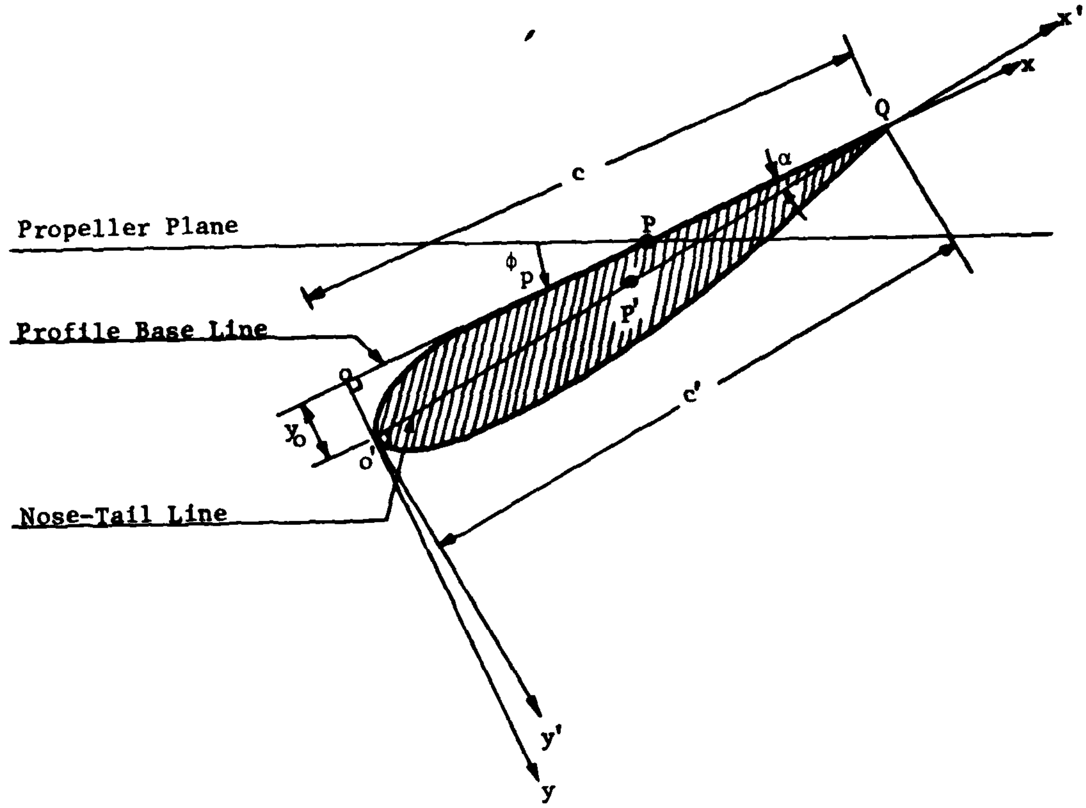


ϕ_p = blade pitch angle

θ_s = skew angle (positive clockwise looking downstream)

i_T = total rake (positive downstream)

Figure 2 - Coordinate System Used in PUF-2



P : Intersection of the profile base line and the center line, or generator line

P': Intersection of the nose-tail line and mid-chord line, or blade-reference line

	ITTC PC	PUF-2
Coord.	oxy	o'x'y'
Pitch Angle	ϕ_p	$\phi_p + \alpha$
Chord Length	c	c'

Figure 3 - Definitions of Blade Surface Ordinates Used in ITTC Propeller Committee and PUF-2

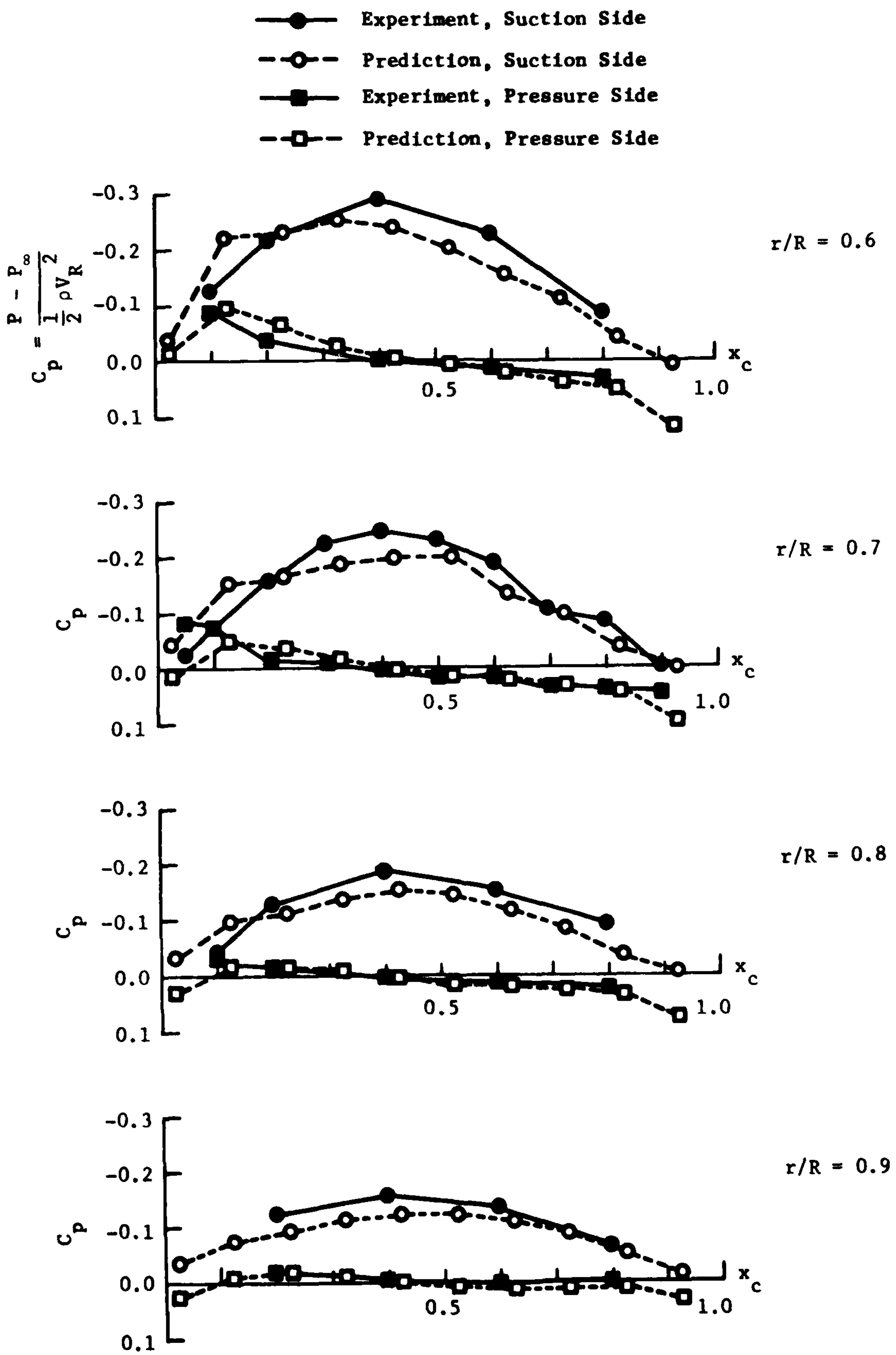


Figure 4 - Comparison of Experimental Measurements and Predictions for Pressure Distribution on the Blade of Model Propeller MP 282 at J = 1.054

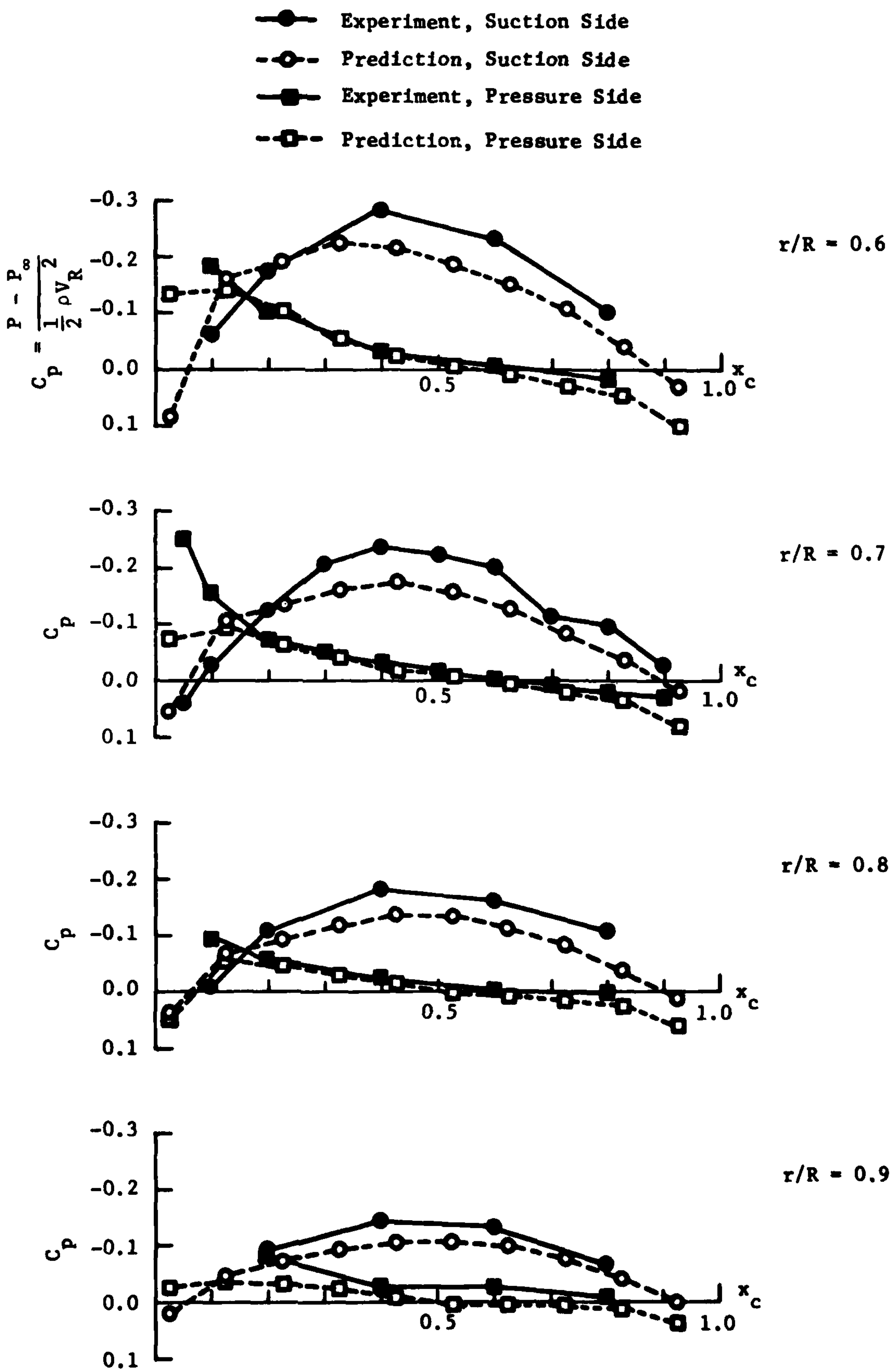
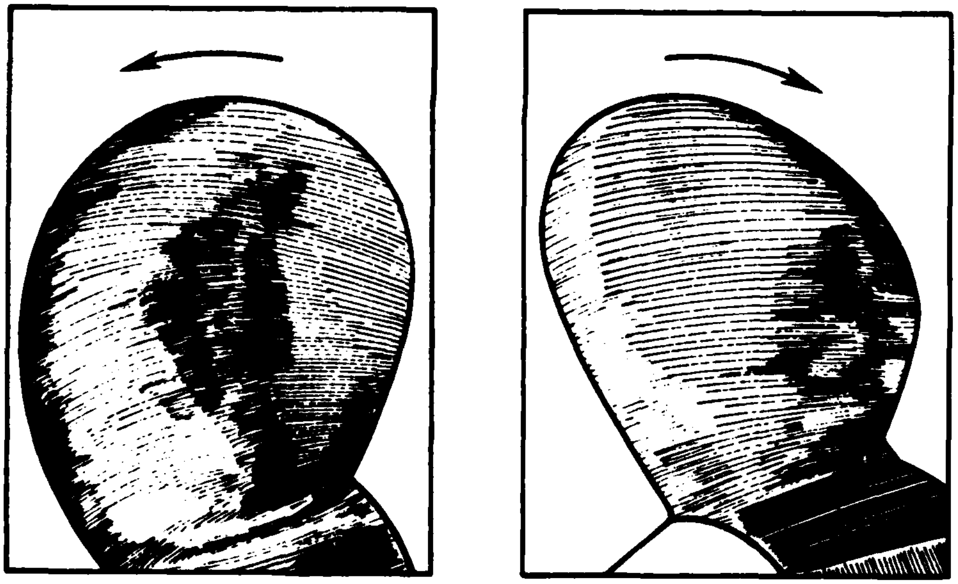


Figure 5 - Comparison of Experimental Measurements and Predictions for Pressure Distribution on the Blade of Model Propeller MP 282 at J = 1.163

SUCTION SIDE PRESSURE SIDE

$R_n = 1.1 \times 10^6$, $J = 1.14$



SUCTION SIDE PRESSURE SIDE

$R_n = 2.6 \times 10^6$, $J = 1.15$

Figure 6 - Surface Flow Patterns by Oil-Film Test

TABLE 1 - PRINCIPAL CHARACTERISTICS OF MODEL PROPELLER MP 282

Diameter (D)	950.0 mm
Pitch (P)	1140.0 mm
Pitch Ratio (P/D) at the Tip	1.20
Boss Ratio (d/D)	0.198
Thickness Ratio (t/D)	0.05
Expanded Area Ratio (A_E/A_O)	0.639
Rake Angle	0 deg
Number of Blades (Z)	4
Blade Section	MAU

r/R	c_{LE} (mm)	c_{TE} (mm)	Pitch Angle (deg)
0.2	132.2	95.8	62.36
0.3	151.7	114.6	51.85
0.4	165.6	132.8	43.68
0.5	174.1	149.2	37.38
0.6	175.3	164.4	32.48
0.7	165.6	175.9	28.62
0.8	138.9	179.6	25.52
0.9	86.1	166.2	23.00
0.95	46.4	144.2	21.90
1.0	-59.2	59.2	20.91

Note: c_{LE}: blade width from the centerline to the leading edge
c_{TE}: blade width from the centerline to the trailing edge
(see Figure 3)

TABLE 2 - GEOMETRY OF MODEL PROPELLER MP 282 IN PUF-2 COORDINATE SYSTEM

NEW GEOMETRY AFTER TRANSFORMATION

XR	PHI(OLD) (DEG)	ALFA(DEG)	PHI(NEW) (DEG)	P/D	RAKE/D	SKEW(DEG)	C/D
.20	62.36350	3.38707	65.75058	1.39485	-.02031	-1.49908	.24053
.30	51.85397	2.55864	54.41262	1.31705	-.01922	-2.72544	.28060
.40	43.67930	1.99543	45.67472	1.28659	-.01592	-2.58464	.31440
.50	37.37779	1.55917	38.93696	1.26915	-.01164	-1.74235	.34044
.60	32.48164	1.18049	33.66213	1.25531	-.00619	-.54638	.35765
.70	28.62015	.82205	29.44220	1.24127	.00033	.98123	.35951
.80	25.52283	.44972	25.97256	1.22432	.00804	2.85812	.33527
.90	22.99701	.13626	23.13326	1.20794	.01610	4.95682	.26558
.95	21.98386	.01018	21.99404	1.20546	.01986	5.76779	.20863
1.00	20.90545	0.00000	20.90545	1.20000	.02224	6.67078	0.00000

TABLE 3 - TABLE OF OFFSETS OF MODEL PROPELLER MP 282 ABOUT PROFILE BASE LINE

ITTC PROP M.P. NO 282 FOR PRESSURE COMPARISON

ORIGINAL OFFSETS IN MM; T.E. OFFSETS OF UPPER SURFACE YU ARE SET TO ZERO FOR CONVENIENCE

XR																		
.23	XC	0.0	4.6	9.1	13.7	22.8	34.2	45.6	68.4	73.0	91.2	114.0	136.8	159.6	182.4	205.3	216.7	228.1
	YU	13.5	20.0	23.1	25.5	29.3	32.9	35.6	38.5	39.6	37.7	34.7	30.1	24.4	17.5	9.8	5.0	0.0
	YL	13.5	9.4	7.4	5.0	3.9	2.1	.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.30	XC	0.0	5.3	13.7	16.0	26.6	40.0	53.3	79.9	85.2	106.5	133.2	159.8	186.4	213.0	239.7	253.0	266.3
	YU	11.9	17.7	20.4	22.6	25.9	29.1	31.5	34.0	34.1	33.4	30.7	26.7	21.5	15.4	8.6	5.1	0.0
	YL	11.9	8.3	6.5	5.1	3.4	1.8	.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.40	XC	0.0	6.0	11.9	17.9	29.9	44.8	59.7	89.5	95.5	113.4	149.2	179.1	208.9	238.8	268.6	283.5	298.5
	YU	18.4	15.4	17.7	19.6	22.5	25.3	27.3	29.6	29.6	29.0	26.7	23.2	18.7	13.4	7.5	4.5	0.0
	YL	18.4	7.2	5.7	4.5	3.0	1.6	.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.50	XC	0.0	6.6	13.1	19.7	32.9	49.2	65.7	98.5	105.1	130.8	162.9	194.9	227.0	259.2	291.2	307.3	323.3
	YU	0.0	13.1	15.1	16.7	19.2	21.5	23.2	25.1	25.2	24.6	22.7	19.7	15.9	11.4	6.4	3.8	0.0
	YL	0.0	5.1	4.0	3.0	2.5	1.4	.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.60	XC	0.0	7.4	14.8	22.2	37.1	55.6	74.1	111.1	118.6	144.6	177.1	209.6	242.1	274.6	307.2	323.4	339.7
	YU	7.0	10.3	12.0	13.4	15.6	17.6	19.0	20.7	20.7	20.2	18.6	16.2	13.1	9.4	5.2	3.1	0.0
	YL	7.0	4.9	3.0	3.0	2.0	1.0	.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.70	XC	0.0	8.6	17.2	25.8	42.9	64.3	85.8	128.7	137.3	161.3	191.3	221.4	251.4	281.4	311.5	326.5	341.5
	YU	4.9	7.0	8.5	9.7	11.6	13.4	14.7	16.2	16.3	15.9	14.6	12.7	10.3	7.4	4.1	2.4	0.0
	YL	4.9	3.3	2.5	1.9	1.3	.7	.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.80	XC	0.0	9.0	18.1	27.1	45.2	67.8	90.4	135.5	144.6	163.0	190.6	216.2	241.7	267.3	292.9	305.7	318.5
	YU	2.5	3.0	4.9	5.9	7.6	9.2	10.5	11.0	11.0	11.5	10.6	9.2	7.4	5.3	3.0	1.0	0.0
	YL	2.5	1.7	1.2	1.0	.6	.3	.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.90	XC	0.0	7.7	15.4	23.1	38.6	57.8	77.1	115.7	123.4	139.6	157.5	176.5	195.5	214.4	233.4	242.8	252.3
	YU	.6	1.5	2.3	3.0	4.2	5.5	6.4	7.3	7.3	7.2	6.0	6.1	5.1	3.0	2.3	1.4	0.0
	YL	.6	.3	.2	.2	.1	.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
.95	XC	0.0	6.0	11.9	17.9	29.8	44.7	59.6	89.4	95.3	106.5	120.5	134.6	148.6	162.6	176.6	183.6	190.6
	YU	.3	1.0	1.5	2.0	2.9	3.0	4.5	5.1	5.1	5.1	4.8	4.3	3.7	2.8	1.7	1.1	0.0
	YL	.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.00	XC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	YU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	YL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 4 - TABLE OF OFFSETS OF MODEL PROPELLER MP 282 ABOUT NOSE-TAIL LINE

TABLE OF OFFSETS IN MM ABOUT NOSE-TAIL LINE AFTER TRANSFORMATION

XR																		
.20	XC	0.0	4.2	8.5	13.0	21.0	33.0	44.2	66.0	71.4	83.6	112.5	135.6	150.7	181.0	205.2	216.0	220.5
	YU	0.0	6.0	10.1	12.0	17.1	21.4	24.8	29.0	29.4	29.5	27.9	24.7	20.3	14.0	8.4	5.1	.0
.20	XC	0.0	4.8	9.4	14.1	23.3	34.8	46.3	69.1	73.7	91.0	114.6	137.4	160.1	182.9	205.7	217.1	220.5
	YL	0.0	-3.0	-5.6	-6.9	-8.2	-9.4	-9.9	-9.4	-9.2	-8.1	-5.7	-5.4	-4.0	-2.7	-1.3	-.7	.0
.30	XC	0.0	5.0	10.3	15.5	25.9	39.2	52.4	78.0	94.1	105.4	132.2	159.0	185.8	212.6	239.6	253.1	266.6
	YU	0.0	6.0	9.0	11.4	15.2	19.0	22.0	25.6	25.0	26.2	24.7	21.9	17.9	13.0	7.4	4.5	0.0
.30	XC	0.0	5.5	10.9	16.3	27.0	40.4	53.7	80.4	85.6	106.9	133.6	160.2	186.7	213.3	240.0	253.3	266.6
	YL	0.0	-3.4	-4.9	-6.1	-7.3	-8.3	-8.7	-8.3	-9.1	-7.1	-5.9	-4.8	-3.6	-2.4	-1.2	-.6	0.0
.40	XC	0.0	5.0	11.6	17.5	29.5	44.3	59.1	88.8	94.8	119.7	148.5	178.5	208.5	238.6	268.5	283.5	298.7
	YU	0.0	5.2	7.7	9.0	13.1	16.5	19.3	22.3	22.5	22.7	21.5	19.0	15.6	11.3	6.5	4.0	-.0
.40	XC	0.0	6.1	12.1	18.1	30.1	45.1	60.0	89.8	95.8	119.7	149.5	179.4	209.1	239.0	268.8	283.7	298.7
	YL	0.0	-3.0	-4.3	-5.3	-6.4	-7.2	-7.6	-7.3	-7.1	-6.2	-5.2	-4.2	-3.1	-2.1	-1.0	-.5	-.0
.50	XC	0.0	6.5	12.9	19.5	32.6	48.8	65.3	98.0	104.6	130.3	162.5	194.5	226.7	259.0	291.2	307.3	323.4
	YU	0.0	4.5	6.7	8.4	11.3	14.0	16.2	19.0	19.3	19.4	18.3	16.2	13.3	9.7	5.5	3.4	0.0
.50	XC	0.0	6.7	13.2	19.8	33.1	49.4	65.9	98.7	135.3	131.0	163.1	195.1	227.2	259.3	291.3	307.4	323.4
	YL	0.0	-2.5	-3.6	-4.5	-5.4	-6.1	-6.4	-6.1	-5.9	-5.2	-4.4	-3.5	-2.6	-1.7	-.9	-.4	0.0
.60	XC	0.0	7.3	14.7	22.1	36.9	55.4	73.8	110.8	119.3	144.3	176.8	209.4	241.9	274.5	307.2	323.4	339.8
	YU	0.0	3.5	5.3	6.9	9.4	11.7	13.5	16.0	16.1	16.2	15.2	13.5	11.1	8.1	4.5	2.4	0.0
.60	XC	0.0	7.4	14.9	22.3	37.2	55.7	74.2	111.2	118.7	144.7	177.2	209.7	242.2	274.7	307.3	323.5	339.8
	YL	0.0	-1.9	-2.9	-3.5	-4.2	-4.9	-5.0	-4.7	-4.6	-4.0	-3.3	-2.7	-2.0	-1.3	-.7	-.3	0.0
.70	XC	0.0	8.6	17.1	25.7	42.8	64.2	85.7	128.5	137.1	161.1	191.1	221.3	251.3	281.3	311.5	326.5	341.5
	YU	0.0	2.2	3.4	5.2	7.3	9.4	11.0	13.1	13.4	13.3	12.4	11.0	9.0	6.5	3.7	2.2	.0
.70	XC	0.0	8.6	17.2	25.8	42.9	64.4	85.9	128.8	137.4	161.4	191.4	221.4	251.4	281.4	311.5	326.5	341.5
	YL	0.0	-1.5	-2.2	-2.6	-3.0	-3.3	-3.4	-3.1	-2.9	-2.6	-2.2	-1.7	-1.3	-.9	-.4	-.2	.0
.80	XC	0.0	8.8	18.1	27.1	45.2	67.7	90.3	135.4	144.5	164.9	198.5	216.1	241.7	267.3	292.9	305.7	318.5
	YU	0.0	1.4	2.5	3.6	5.5	7.2	8.7	10.4	10.4	10.3	9.6	8.4	6.8	4.9	2.8	1.7	.0
.80	XC	0.0	8.8	18.1	27.1	45.2	67.8	90.4	135.5	144.6	165.0	190.6	216.2	241.7	267.3	292.9	305.7	318.5
	YL	0.0	-.7	-1.2	-1.3	-1.5	-1.7	-1.7	-1.4	-1.4	-1.2	-1.0	-.8	-.6	-.4	-.2	-.1	.0
.90	XC	0.0	7.7	15.4	23.1	38.6	57.8	77.1	115.7	123.4	138.6	157.5	176.5	195.5	214.4	233.4	242.8	252.3
	YU	0.0	.9	1.7	2.5	3.7	5.0	6.0	7.0	7.0	6.9	6.6	5.9	5.0	3.7	2.3	1.4	0.0
.90	XC	0.0	7.7	15.4	23.1	38.6	57.8	77.1	115.7	123.4	138.6	157.5	176.5	195.5	214.4	233.4	242.8	252.3
	YL	0.0	-.3	-.4	-.3	-.4	-.4	-.4	-.3	-.3	-.3	-.2	-.2	-.1	-.1	-.0	-.0	0.0
.95	XC	0.0	6.0	11.9	17.9	29.8	44.7	59.6	89.4	95.3	106.5	120.5	134.6	148.6	162.6	176.6	183.6	190.6
	YU	0.0	.7	1.2	1.7	2.6	3.6	4.3	4.9	4.9	5.0	4.7	4.2	3.6	2.0	1.7	1.1	.0
.95	XC	0.0	6.0	11.9	17.9	29.8	44.7	59.6	89.4	95.3	106.5	120.5	134.6	148.6	162.6	176.6	183.6	190.6
	YL	0.0	-.3	-.3	-.3	-.3	-.2	-.2	-.2	-.1	-.1	-.1	-.1	-.1	-.0	-.0	-.0	.0

TABLE 5 - TABLE OF OFFSETS OF MODEL PROPELLER MP 282 WITH CAMBER AND THICKNESS

XC: CHORD LENGTH, YU: UPPER SURFACE, YL: LOWER SURFACE, C: CAMBER, T: THICKNESS (ALL IN MM)

.20	XC	0.0	2.3	5.7	11.4	22.8	45.7	68.5	91.4	114.2	137.1	159.9	182.8	205.6	217.1	222.8	226.2	229.5
	YU	0.0	4.0	8.3	11.7	17.6	25.1	29.2	29.5	27.7	24.4	20.0	14.5	9.3	5.0	2.7	1.1	.0
	YL	0.0	-2.0	-4.3	-6.1	-8.2	-9.9	-9.5	-8.1	-5.8	-5.4	-4.1	-2.7	-1.4	-.7	-.3	-.1	.0
	C	0.000	1.003	1.932	2.871	4.683	7.635	9.447	10.694	10.473	9.495	7.991	5.985	3.479	2.166	1.163	.474	.000
	T	0.000	6.004	12.537	19.013	25.739	35.016	38.623	37.595	34.459	29.808	24.095	17.220	9.662	5.645	3.002	1.219	0.000
	C(INCH)	0.0000	.0395	.0786	.1130	.1844	.3006	.3477	.4236	.4123	.3738	.3146	.2325	.1370	.0853	.0458	.0187	.3000
	T(INCH)	0.0000	.2364	.4936	.7092	1.0133	1.3785	1.5206	1.4801	1.3570	1.1735	.9486	.6779	.3804	.2230	.1182	.0480	0.0000
.30	XC	0.0	2.7	6.7	13.3	26.7	53.3	80.0	106.6	133.3	159.9	186.6	213.3	239.9	253.2	259.9	263.9	266.6
	YU	0.0	3.5	7.2	10.4	15.4	22.1	25.7	25.2	24.6	21.0	17.0	12.9	7.3	4.5	2.4	1.3	0.3
	YL	0.0	-1.8	-3.9	-5.5	-7.3	-8.7	-9.3	-7.1	-6.0	-4.8	-3.6	-2.4	-1.2	-.6	-.3	-.1	-.0
	C	0.000	.845	1.694	2.453	4.056	6.720	8.696	9.524	9.342	8.515	7.101	5.248	3.077	1.927	1.038	.424	-.000
	T	0.000	5.319	11.060	15.835	22.672	30.849	34.065	33.350	30.535	26.559	21.350	15.262	8.536	5.046	2.672	1.085	.060
	C(INCH)	0.0000	.0333	.0667	.0970	.1597	.2646	.3424	.3751	.3678	.3352	.2796	.2066	.1211	.0759	.0409	.0167	-.0000
	T(INCH)	0.0000	.2094	.4354	.6234	.8926	1.2145	1.3411	1.3130	1.2345	1.0456	.8406	.6009	.3361	.1987	.1052	.0427	.0000
.40	XC	0.0	3.0	7.5	14.9	29.9	59.7	89.6	119.5	149.3	179.2	209.1	238.9	268.8	283.7	291.2	295.7	298.7
	YU	0.0	2.9	6.1	8.9	13.2	19.1	22.3	22.7	21.4	19.0	15.5	11.3	6.4	3.9	2.1	.9	-.0
	YL	0.0	-1.6	-3.4	-4.9	-6.3	-7.6	-7.3	-6.2	-5.2	-4.2	-3.1	-2.1	-1.8	-.5	-.3	-.1	-.0
	C	0.000	.656	1.365	2.057	3.449	5.729	7.529	8.246	8.115	7.400	6.185	4.585	2.686	1.785	.927	.377	-.000
	T	0.000	4.556	9.537	13.652	19.578	26.692	29.626	28.973	26.536	23.124	18.615	13.332	7.454	4.450	2.364	.961	.030
	C(INCH)	0.0000	.0258	.0538	.0810	.1357	.2255	.2964	.3246	.3195	.2913	.2435	.1805	.1058	.0671	.0363	.0148	-.0000
	T(INCH)	0.0000	.1794	.3755	.5375	.7705	1.0505	1.1664	1.1409	1.0457	.9134	.7329	.5249	.2935	.1752	.0931	.0378	.0038
.50	XC	0.0	3.2	8.1	16.2	32.3	64.7	97.0	129.4	161.7	194.1	226.4	258.7	291.1	307.2	315.3	320.2	323.4
	YU	0.0	2.5	5.2	7.5	11.2	16.1	18.9	19.4	18.4	15.2	13.3	9.7	5.5	3.4	1.9	.7	.0
	YL	0.0	-1.4	-2.9	-4.0	-5.4	-6.4	-6.2	-5.3	-4.4	-3.5	-2.6	-1.8	-.9	-.4	-.2	-.1	0.0
	C	0.000	.551	1.169	1.758	2.937	4.859	6.382	7.343	6.991	6.359	5.333	3.964	2.227	1.459	.794	.324	.000
	T	0.000	3.807	8.058	11.561	16.609	22.508	25.081	24.650	22.766	19.759	15.940	11.450	6.414	3.816	2.020	.825	.000
	C(INCH)	0.0000	.0217	.0460	.0692	.1155	.1913	.2513	.2773	.2749	.2503	.2100	.1561	.0516	.0578	.0313	.0128	.0000
	T(INCH)	0.0000	.1499	.3173	.4551	.6539	.8852	.9874	.9705	.8963	.7779	.6279	.4508	.2525	.1502	.0798	.0325	.0000
.60	XC	0.0	3.4	8.5	17.0	34.0	68.0	101.9	135.9	169.9	203.9	237.8	271.8	305.8	322.8	331.3	336.4	339.8
	YU	0.0	1.7	3.8	5.8	8.9	13.0	15.6	16.2	15.5	13.9	11.4	8.3	4.7	2.0	1.5	.5	.0
	YL	0.0	-1.0	-2.1	-3.1	-4.1	-5.0	-4.8	-4.2	-3.5	-2.8	-2.1	-1.4	-.7	-.4	-.2	-.1	0.0
	C	0.000	.385	.851	1.367	2.402	4.012	5.389	6.022	6.010	5.530	4.461	3.467	1.994	1.249	.679	.278	.000
	T	0.000	2.729	5.977	8.881	13.046	17.971	20.468	20.441	19.022	16.551	13.523	9.735	5.360	3.199	1.709	.696	.000
	C(INCH)	0.0000	.0152	.0335	.0538	.0946	.1580	.2122	.2371	.2366	.2177	.1835	.1365	.0781	.0492	.0267	.0109	.0000
	T(INCH)	0.0000	.1074	.2353	.3496	.5136	.7075	.8058	.8048	.7489	.6559	.5324	.3833	.2113	.1259	.0673	.0274	.0000
.70	XC	0.0	3.4	8.5	17.1	34.2	68.3	102.5	136.6	170.8	204.9	239.1	273.2	307.4	324.5	333.0	338.1	341.5
	YU	0.0	.9	2.2	3.6	6.3	9.8	12.0	13.4	13.1	11.8	9.9	7.3	4.0	2.4	1.3	.5	.0
	YL	0.0	-.7	-1.5	-2.1	-2.9	-3.3	-3.3	-2.9	-2.5	-2.0	-1.5	-1.0	-.5	-.2	-.1	-.0	.0
	C	0.000	.141	.375	.845	1.712	3.226	4.359	5.209	5.320	4.959	4.198	3.140	1.778	1.099	.594	.243	.000
	T	0.000	1.587	3.682	5.979	9.169	13.081	15.344	16.308	15.557	13.739	11.336	8.240	4.537	2.667	1.433	.585	0.000
	C(INCH)	0.0000	.0055	.0148	.0333	.0674	.1270	.1716	.2051	.2098	.1945	.1653	.1236	.0700	.0429	.0234	.0096	.0000
	T(INCH)	0.0000	.0625	.1450	.2354	.3610	.5150	.6041	.6417	.6125	.5413	.4463	.3244	.1786	.1050	.0564	.0230	0.0000
.80	XC	0.0	3.2	8.0	15.9	31.9	63.7	95.6	127.4	159.3	191.1	223.0	254.8	286.7	302.6	310.5	315.3	318.5
	YU	0.0	.6	1.4	2.3	4.2	6.9	9.0	10.2	10.4	9.6	8.0	5.9	3.3	2.0	1.1	.5	.0
	YL	0.0	-.3	-.7	-1.1	-1.4	-1.7	-1.7	-1.5	-1.3	-1.0	-.8	-.5	-.3	-.1	-.1	-.0	.0
	C	0.000	.129	.312	.638	1.408	2.641	3.660	4.362	4.562	4.237	3.626	2.680	1.522	.943	.525	.217	.000
	T	0.000	.899	2.093	3.413	5.506	8.597	10.690	11.722	11.623	10.574	8.753	6.360	3.544	2.137	1.178	.484	.000
	C(INCH)	0.0000	.0051	.0123	.0236	.0551	.1040	.1441	.1717	.1796	.1668	.1428	.1055	.0599	.0371	.0207	.0085	.0000
	T(INCH)	0.0000	.0354	.0824	.1344	.2168	.3385	.4205	.4615	.4576	.4163	.3446	.2504	.1395	.0841	.0464	.0190	.0000
.90	XC	0.0	2.5	6.3	12.6	25.2	50.5	75.7	100.9	126.2	151.4	176.6	201.8	227.1	239.7	246.0	249.8	252.3
	YU	0.0	.3	.9	1.5	2.6	4.6	5.9	6.8	7.0	6.7	5.9	4.6	2.8	1.7	1.0	.4	0.0
	YL	0.0	-.1	-.2	-.4	-.3	-.4	-.4	-.4	-.3	-.2	-.2	-.1	-.1	-.0	-.0	-.0	0.0
	C	0.000	.101	.258	.550	1.146	2.089	2.757	3.190	3.346	3.242	2.867	2.227	1.347	.842	.472	.195	0.000
	T	0.000	.413	1.001	1.888	2.985	4.944	6.339	7.130	7.292	6.964	6.094	4.693	2.814	1.743	.975	.402	0.000
	C(INCH)	0.0000	.0040	.0101	.0216	.0451	.0822	.1085	.1256	.1317	.1276	.1129	.0877	.0530	.0331	.0186	.0077	0.0000
	T(INCH)	0.0000	.0163	.0394	.0712	.1175	.1947	.2496	.2810	.2871	.2742	.2399	.1848	.1108	.0686	.0384	.0158	0.0000
.95	XC	0.0	1.9	4.8	9.5	19.1	38.1	57.2	76.2	95.3	114.4	133.4	152.5	171.5	181.1	185.8	188.7	190.6
	YU	0.0	.2	.6	1.0	1.8	3.2	4.2	4.8	5.0	4.9	4.3	3.4	2.1	1.3	.8	.3	.0
	YL	0.0	-.1	-.3	-.3	-.3	-.2	-.2	-.2	-.2	-.1	-.1	-.1	-.0	-.0	-.0	-.0	.0
	C	0.000	.062	.162	.361	.777	1.475	1.991	2.307	2.480	2.366	2.082	1.682	1.014	.665	.398	.163	.000
	T	0.000	.355	.833	1.338	2.098	3.428	4.403	4.973	5.108	4.972	4.345	3.485	2.087	1.360	.796	.332	.000
	C(INCH)	0.0000	.0025	.0064	.0142	.0306	.0581	.0784	.0909	.0965	.0931	.0820	.0662	.0399	.0262	.0156	.0064	.0000
	T(INCH)	0.0000	.0140	.0328	.0524	.0826	.1350	.1733	.1958	.2008	.1957	.1710	.1372	.0822	.0535	.0313	.0131	.0000

TABLE 6 - COMPARISON OF OPEN-WATER PERFORMANCE OF MODEL PROPELLER MP 282

J	Experiments			Numerical		
	K_T	$10\ K_Q$	η	K_T	$10\ K_Q$	η
0.9	-	-	-	0.188	0.388	0.702
0.95	-	-	-	0.168	0.348	0.724
1.0	0.1669	0.340	0.797	0.144	0.312	0.742
1.054	0.1405	0.294	0.8025	0.120	0.268	0.753
1.1	0.1184	0.256	0.803	0.100	0.232	0.754
1.163	0.088	0.205	0.7865	0.072	0.180	0.729

TABLE 7 - PREDICTED PRESSURE DISTRIBUTION AND LIFT COEFFICIENTS AT J = 0.9

--- MIT PUF-2 ---

TABULATED SOLUTION OF PRESSURE DISTRIBUTION CP, DENOMINATOR CODE = 1
AND LIFT COEF. CL (1 LOCAL INFLOW VEL. 2 SHIP SPEED 3 UR (0.7R))

ITTC PROP M.P. NO 282 (4-BLADED): PRESSURE DISTRIBUTION

R/R0	.025	.125	.225	.325	.425	.525	.625	.725	.825	.925	OF C: CL	
.300	-.383	-.623	-.603	-.583	-.477	-.374	-.291	-.204	-.087	-.031		S
	-.155	-.253	-.188	-.106	-.065	-.038	-.011	.021	.056	.200	.309	P
.400	-.306	-.506	-.501	-.493	-.407	-.320	-.239	-.156	-.048	-.031		S
	.055	-.132	-.105	-.044	-.013	.009	.029	.053	.080	.200	.309	P
.500	-.265	-.396	-.382	-.383	-.325	-.262	-.195	-.129	-.039	-.034		S
	.133	-.059	-.050	-.008	.012	.027	.039	.056	.073	.172	.275	P
.600	-.225	-.301	-.286	-.292	-.262	-.216	-.165	-.112	-.037	-.034		S
	.157	-.014	-.015	.012	.025	.033	.041	.051	.063	.145	.238	P
.700	-.189	-.216	-.209	-.216	-.218	-.184	-.144	-.100	-.039	-.035		S
	.151	.014	.011	.019	.032	.035	.039	.045	.053	.117	.202	P
.800	-.149	-.151	-.153	-.167	-.175	-.159	-.130	-.094	-.042	-.034		S
	.128	.031	.020	.021	.030	.033	.035	.037	.042	.088	.168	P
.900	-.126	-.118	-.125	-.141	-.146	-.143	-.132	-.107	-.070	-.039		S
	.093	.031	.016	.015	.019	.024	.025	.018	.016	.038	.141	P

TABLE 8 - PREDICTED PRESSURE DISTRIBUTION AND LIFT COEFFICIENTS AT J = 0.95

--- MIT PUF-2 ---

TABULATED SOLUTION OF PRESSURE DISTRIBUTION CP, DENOMINATOR CODE = 1
AND LIFT COEF. CL (1 LOCAL INFLOW VEL. 2 SHIP SPEED 3 UR (0.7R))

ITTC PROP M.P. NO 282 (4-BLADED): PRESSURE DISTRIBUTION

R/RO	.025	.125	.225	.325	.425	.525	.625	.725	.825	.925OF C:	CL	
.300	-.287	-.580	-.576	-.564	-.466	-.367	-.286	-.201	-.084	-.009		S
	-.232	-.278	-.202	-.114	-.070	-.042	-.013	.019	.054	.191	.274	P
.400	-.217	-.468	-.477	-.478	-.399	-.316	-.238	-.157	-.051	-.012		S
	-.019	-.163	-.125	-.058	-.024	-.000	.022	.047	.074	.189	.273	P
.500	-.189	-.364	-.363	-.370	-.317	-.258	-.194	-.130	-.042	-.017		S
	.068	-.089	-.070	-.023	.000	.018	.032	.049	.068	.162	.243	P
.600	-.163	-.276	-.269	-.281	-.255	-.212	-.163	-.112	-.039	-.020		S
	.103	-.039	-.033	-.002	.014	.024	.034	.045	.059	.136	.210	P
.700	-.139	-.195	-.195	-.207	-.211	-.180	-.141	-.099	-.039	-.022		S
	.108	-.007	-.004	.006	.022	.026	.032	.039	.049	.110	.178	P
.800	-.110	-.135	-.141	-.158	-.168	-.154	-.126	-.091	-.041	-.024		S
	.096	.014	.008	.010	.021	.026	.029	.032	.038	.083	.148	P
.900	-.093	-.103	-.114	-.130	-.136	-.134	-.123	-.098	-.062	-.029		S
	.073	.018	.007	.008	.013	.019	.021	.016	.015	.039	.123	P

TABLE 9 - PREDICTED PRESSURE DISTRIBUTION AND LIFT COEFFICIENTS AT J = 1.0

--- MIT PUF-2 ---

TABULATED SOLUTION OF PRESSURE DISTRIBUTION CP, DENOMINATOR CODE = 1
AND LIFT COEF. CL (1 LOCAL INFLOW VEL. 2 SHIP SPEED 3 UR (0.7R))

ITTC PROP M.P. NO 282 (4-BLADED): PRESSURE DISTRIBUTION

R/RO	.025	.125	.225	.325	.425	.525	.625	.725	.825	.925OF C*	CL	
.300	-.196	-.538	-.549	-.546	-.454	-.360	-.281	-.197	-.082	.010		S
	-.308	-.302	-.215	-.122	-.076	-.046	-.016	.016	.052	.181	.239	P
.400	-.132	-.430	-.453	-.463	-.390	-.312	-.237	-.158	-.053	.005		S
	-.094	-.194	-.145	-.072	-.035	-.009	.014	.040	.069	.178	.238	P
.500	-.116	-.333	-.342	-.357	-.309	-.254	-.193	-.131	-.044	-.002		S
	.003	-.117	-.089	-.037	-.011	.009	.024	.043	.063	.152	.211	P
.600	-.103	-.250	-.253	-.269	-.247	-.207	-.161	-.112	-.040	-.007		S
	.048	-.064	-.051	-.016	.003	.016	.027	.040	.054	.128	.182	P
.700	-.091	-.174	-.181	-.197	-.204	-.175	-.138	-.098	-.039	-.011		S
	.065	-.028	-.019	-.005	.012	.019	.026	.035	.046	.103	.154	P
.800	-.072	-.118	-.130	-.149	-.161	-.149	-.123	-.089	-.040	-.014		S
	.063	-.042	-.004	.000	.013	.019	.024	.028	.035	.078	.128	P
.900	-.063	-.089	-.103	-.121	-.128	-.126	-.116	-.091	-.056	-.021		S
	.052	.006	-.003	.000	.007	.015	.018	.014	.015	.040	.106	P

TABLE 10 - PREDICTED PRESSURE DISTRIBUTION AND LIFT COEFFICIENTS AT J = 1.054

--- MIT PUF-2 ---

TABULATED SOLUTION OF PRESSURE DISTRIBUTION CP, DENOMINATOR CODE = 1
AND LIFT COEF. CL (1 LOCAL INFLOW VEL. 2 SHIP SPEED 3 UR (0.7R))

ITTC PROP M.P. NO 282 (4-BLADED): PRESSURE DISTRIBUTION

R/R0	.025	.125	.225	.325	.425	.525	.625	.725	.825	.925 OF C:	CL	
.300	-.105	-.494	-.520	-.527	-.442	-.352	-.277	-.194	-.080	.027		S
	-.389	-.328	-.229	-.130	-.082	-.050	-.020	.013	.049	.170	.202	P
.400	-.046	-.389	-.426	-.445	-.379	-.306	-.235	-.158	-.055	.021		S
	-.174	-.225	-.165	-.087	-.046	-.018	.007	.034	.063	.166	.200	P
.500	-.041	-.298	-.320	-.342	-.299	-.248	-.191	-.131	-.045	.012		S
	-.068	-.147	-.110	-.052	-.023	-.001	.016	.037	.058	.141	.177	P
.600	-.040	-.221	-.234	-.256	-.239	-.202	-.159	-.111	-.041	.006		S
	-.012	-.091	-.069	-.029	-.008	.007	.019	.034	.050	.118	.152	P
.700	-.041	-.152	-.166	-.185	-.196	-.170	-.135	-.097	-.039	-.000		S
	.017	-.049	-.035	-.017	.003	.011	.020	.030	.042	.096	.129	P
.800	-.033	-.100	-.117	-.139	-.154	-.143	-.119	-.086	-.038	-.005		S
	.027	-.019	-.017	-.010	.004	.013	.019	.024	.033	.073	.108	P
.900	-.033	-.074	-.091	-.111	-.119	-.119	-.109	-.085	-.050	-.012		S
	.028	-.007	-.013	-.007	.001	.010	.015	.012	.014	.039	.089	P

TABLE 11 - PREDICTED PRESSURE DISTRIBUTION AND LIFT COEFFICIENTS AT J = 1.1

--- MIT PUF-2 ---

TABULATED SOLUTION OF PRESSURE DISTRIBUTION CP, DENOMINATOR CODE = 1
AND LIFT COEF. CL (1 LOCAL INFLOW VEL. 2 SHIP SPEED 3 UR (0.7R))

ITTC PROP M.P. NO 282 (4-BLADED): PRESSURE DISTRIBUTION

R/R0	.025	.125	.225	.325	.425	.525	.625	.725	.825	.925	OF C* CL	
.300	-.033	-.458	-.496	-.510	-.431	-.346	-.273	-.191	-.078	.040		S
	-.457	-.348	-.240	-.138	-.088	-.055	-.024	.009	.045	.160	.172	P
.400	.024	-.354	-.404	-.430	-.369	-.301	-.233	-.158	-.056	.034		S
	-.243	-.252	-.181	-.098	-.055	-.025	.001	.028	.059	.155	.168	P
.500	.020	-.269	-.301	-.328	-.291	-.243	-.188	-.130	-.047	.023		S
	-.129	-.172	-.126	-.064	-.032	-.008	.010	.031	.054	.132	.148	P
.600	.012	-.197	-.218	-.245	-.231	-.197	-.156	-.110	-.041	.015		S
	-.064	-.113	-.084	-.040	-.016	-.000	.014	.029	.047	.110	.127	P
.700	.009	-.132	-.153	-.175	-.189	-.165	-.133	-.095	-.039	.008		S
	-.025	-.068	-.047	-.027	-.005	.005	.015	.026	.040	.090	.108	P
.800	-.002	-.085	-.106	-.131	-.147	-.138	-.116	-.085	-.037	.003		S
	-.004	-.034	-.027	-.018	-.002	.008	.015	.022	.031	.068	.090	P
.900	-.009	-.061	-.082	-.103	-.112	-.113	-.104	-.081	-.046	-.006		S
	.006	-.018	-.021	-.014	-.003	.007	.012	.010	.014	.039	.075	P

TABLE 12 - PREDICTED PRESSURE DISTRIBUTION AND LIFT COEFFICIENTS AT J = 1.163

--- MIT PUF-2 ---

TABULATED SOLUTION OF PRESSURE DISTRIBUTION CP, DENOMINATOR CODE = 1
AND LIFT COEF. CL (1 LOCAL INFLOW VEL. 2 SHIP SPEED 3 UR (0.7R))

ITTC PROP M.P. NO 282 (4-BLADED): PRESSURE DISTRIBUTION

R/R0	.025	.125	.225	.325	.425	.525	.625	.725	.825	.925OF C:	CL	
.300	.058	-.410	-.465	-.488	-.417	-.337	-.268	-.188	-.077	.054		S
	-.547	-.376	-.255	-.148	-.095	-.061	-.029	.003	.040	.145	.132	P
.400	.114	-.308	-.373	-.408	-.356	-.293	-.229	-.157	-.057	.048		S
	-.335	-.286	-.203	-.113	-.067	-.035	-.008	.021	.052	.140	.126	P
.500	.100	-.230	-.274	-.309	-.278	-.236	-.184	-.129	-.048	.036		S
	-.213	-.205	-.148	-.080	-.044	-.018	.002	.024	.048	.119	.109	P
.600	.079	-.165	-.196	-.229	-.220	-.190	-.152	-.109	-.042	.027		S
	-.135	-.142	-.104	-.055	-.028	-.009	.006	.024	.042	.100	.093	P
.700	.054	-.106	-.134	-.161	-.179	-.158	-.128	-.093	-.038	.019		S
	-.083	-.092	-.064	-.040	-.015	-.003	.009	.022	.036	.081	.080	P
.800	.039	-.065	-.091	-.119	-.138	-.132	-.112	-.082	-.036	.012		S
	-.048	-.053	-.041	-.029	-.011	.001	.010	.018	.028	.062	.068	P
.900	.020	-.045	-.069	-.092	-.104	-.106	-.099	-.077	-.042	.002		S
	-.026	-.033	-.031	-.022	-.009	.003	.009	.009	.014	.037	.057	P

TABLE 13 - EXPERIMENTAL MEASUREMENTS[1] OF PRESSURE DISTRIBUTION ON THE MODEL PROPELLER MP 282 AT J = 1.054 AND J = 1.163 (FROM REFERENCE 3)

J	r/R \ Fraction of chord		0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1.054[2]	0.6	Back	-	-.123	-.220	-	-.293	-	-.231	-	-.089	-
		Face	-	-.089	-.040	-	-.003	-	.010	-	.029	-
	0.7	Back	-.026	-.070	-.156	-.222	-.244	-.230	-.190	-.105	-.087	-.002
		Face	-.080	-.074	-.015	-.011	.008	.017	.018	.032	.037	.048
	0.8	Back	-	-.045	-.129	-	-.188	-	-.152	-	-.093	-
		Face	-	-.031	-.013	-	.004	-	.012	-	.021	-
	0.9	Back	-	-	-.121	-	-.152	-	-.131	-	-.063	-
		Face	-	-	-.016	-	-.002	-	.001	-	.002	-
1.054[3]	0.7	Back	-.029	-.079	-.162	-.226	-.252	-.229	-.193	-.109	-.086	-.010
		Face	-.097	-.077	-.020	-.016	.003	.011	.018	.026	.029	.049
1.163[4]	0.6	Back	-	-.065	-.179	-	-.285	-	-.235	-	-.104	-
		Face	-	-.187	-.104	-	-.035	-	-.010	-	.016	-
	0.7	Back	.041	-.029	-.127	-.206	-.239	-.225	-.201	-.113	-.097	-.027
		Face	-.251	-.154	-.072	-.051	-.032	-.017	-.004	.009	.020	.030
	0.8	Back	-	-.009	-.109	-	-.182	-	-.161	-	-.108	-
		Face	-	-.093	-.056	-	-.025	-	-.008	-	.005	-
	0.9	Back	-	-	-.094	-	-.144	-	-.131	-	-.067	-
		Face	-	-	-.081	-	-.028	-	-.028	-	-.008	-

Note: 1. For all tests, the Reynolds number was 1.9×10^6.
2. This test was made on 3 March 1978. The water temperature was 10.2° C.
3. This is a repeated test made on 6 March 1978. The water temperature was 10.3° C.
4. This test was made on 20 April 1978. The water temperature was 12.1°C.

DTNSRDC ISSUES THREE TYPES OF REPORTS

1. DTNSRDC REPORTS, A FORMAL SERIES, CONTAIN INFORMATION OF PERMANENT TECHNICAL VALUE. THEY CARRY A CONSECUTIVE NUMERICAL IDENTIFICATION REGARDLESS OF THEIR CLASSIFICATION OR THE ORIGINATING DEPARTMENT.

2. DEPARTMENTAL REPORTS, A SEMIFORMAL SERIES, CONTAIN INFORMATION OF A PRELIMINARY, TEMPORARY, OR PROPRIETARY NATURE OR OF LIMITED INTEREST OR SIGNIFICANCE. THEY CARRY A DEPARTMENTAL ALPHANUMERICAL IDENTIFICATION.

3. TECHNICAL MEMORANDA, AN INFORMAL SERIES, CONTAIN TECHNICAL DOCUMENTATION OF LIMITED USE AND INTEREST. THEY ARE PRIMARILY WORKING PAPERS INTENDED FOR INTERNAL USE. THEY CARRY AN IDENTIFYING NUMBER WHICH INDICATES THEIR TYPE AND THE NUMERICAL CODE OF THE ORIGINATING DEPARTMENT. ANY DISTRIBUTION OUTSIDE DTNSRDC MUST BE APPROVED BY THE HEAD OF THE ORIGINATING DEPARTMENT ON A CASE-BY-CASE BASIS.

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